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Precaspian Isthmus emergence triggered the Early Sakmarian glaciation: Evidence from the Lower Permian of the Urals, Russia

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ABSTRACT

The sub-meridional seaway that connected Paleo-Arctic and Paleo-Tethys basins was one of the most important geographical attributes of the Late Paleozoic Pangean landscape, paleogeography and paleoclimate. Existing models about the timing of the disconnection of the Paleo-Arctic and the Paleo-Tethyan oceans is controversial and poorly documented. Warm-water benthic foraminifera (WWBF) were utilized to establish the precise timing of the closure of the Urals-Precaspian-Paleo-Tethys Seaway (UPTS) during Cisuralian time. The WWBF of Paleo-Tethys and those of the Ural—Precaspian Basins during the Gzhelian-Asselian, display a considerably high level of similarity. Beginning from the Sakmarian, the faunas of these two regions became dissimilar, suggesting a break in the connection between the Paleo-Tethys and Ural-Precaspian Basins. Sedimentological evidence (olistostromes and seismites) of the final collision of the Eastern Ural, Kazakhstania, Scythian-Turan plates with the southeastern part of the Russian Platform during Late Paleozoic also supports the emergence of the Precaspian Isthmus at the Asselian-Sakmarian transition. Oceanic currents in the Precaspian and the Southern Ural Basins before the Sakmarian were directed northward and later changed to the south. The biotic and sedimentologic features clearly suggest the UPTS closure and the origination of Precaspian Isthmus during the Asselian-Sakmarian transition. The abrupt changes in the oceanic circulation triggered changes in atmospheric CO_2, atmospheric circulation and, possibly, albedo feedback. The emergence of the Precaspian Isthmus induced an increase in the poleward salt and heat transport towards mid- to lower latitude Gondwana and Cathasia margins. The warm water currents and moisture along the margins of Gondwana caused a rapid increase in the precipitation necessary to build significant ice sheets during the early-middle Sakmarian.

1. Introduction

The Late Paleozoic glaciation is a very intriguing and controversial matter and is the penultimate icehouse-greenhouse transition on Earth (Crowell, 1999; Montanez and Poulsen, 2013; Smith and Read, 2000). Our understanding of the processes associated with the glaciation, and particularly the factors that caused the icehouse to greenhouse transition, may help us better understand the changes to recent climate perturbations. The level of atmospheric CO_2 is considered the major factor that drives climate change along with the other less important, such as tectonics, continents configuration, variations of the orbital and spin axis of the Earth and other extraterrestrial events (Montanez and Poulsen, 2013; Smith and Read, 2000). However, the factors behind CO_2 fluctuations in the past are unclear. The role of paleogeographic configuration and solar irradiation is considered of secondary importance (Lowry et al., 2014).

The sub-meridional seaway that connected Paleo-Arctic and Paleo-Tethys basins was one of the most important geographical attributes of the Late Paleozoic Pangea landscape, paleogeography and paleoclimate (Scotese, 2015). The seaway which connected the shelves along the East-European Craton, the Ural and the Paleo-Tethys was the major oceanic gateway between the oceans in the Paleo-Tethys and Paleo-Arctic (Fig. 1). The final collision of Kazakhstania and Siberian continents with the sutured Laurentia and Gondwana is usually considered to have caused the closure of the Uralian foredeep and UPTS sometime in latest Cisuralian time (Puchkov, 2010). Most tectonic models of the development of the Ural and the surrounding areas during Paleozoic-Mesozoic time imply the existence of the UPTS until the Kungurian because of the early Permian marine sedimentation in the Precaspian and the Southern Ural. According to these models, the end of the

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